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Psychological and Demographic Factors Affecting Household Energy-Saving Intentions: A TPB-Based Study in Northwest China

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Abstract: Changing energy consumption behavior is a promising strategy to enhance household energy efficiency and to reduce carbon emission. Understanding the role of psychological and demographic factors in the context of energy-conservation behaviors is critical to promote energy-saving behaviors in buildings. This study first proposes a theoretical framework built on the Theory of Planned Behavior (TPB). Based on the collected survey data from 207 families (553 residents) in three communities in Xi'an, a typical city in northwest China, the research examines how three standard TPB predictors, namely attitude, subjective norm, and perceived behavioral control, as well as their interactive effects and three socio-demographic factors (i.e., house ownership, education and household income) influence building occupants' energy-saving intention at home. Through structural equation modeling and keyword analysis, this study reveals that two interaction terms, namely attitude and subjective norms, as well as attitude and perceived behavior control, significantly influence building occupants' energy-saving intention. Furthermore, this study implies that household income may positively associate with occupants' energy-saving intention. The model in this study would be conducive to architects and property managers to mitigate severe building energy overuse problem in design and operation stages. Based on a qualitative analysis, the study then discusses the limitations of the study and further research direction. The results of this study would be conducive to building designers and operators to develop customized architectural or informatic interventions and to mitigate the severe energy overuse problem in the residential sector in northwest China.

Keywords: energy-saving; pro-environmental behavior; household; theory of planned behavior (TPB); northwest China

1. Introduction

The growing global energy consumption has raised serious concerns over resource exhaustion and a series of environmental problems. The residential building sector has been one of the largest energy consumers and accounts for 20%–40% energy consumption as well as carbon emission [1–8]. Along with energy-efficient construction techniques and building services, occupants' choices and behaviors are critical factors contributing to residential building energy consumption [9,10]. Household energy-saving behavior is defined as "residents' behaviors for minimizing energy consumption due to their actions in the built environment." Existing studies point out that promoting energy-saving behavior is a promising strategy for enhancing building energy efficiency [11–13]. In particular, behavior-driven energy-saving approaches generally require less capital and time investment [14] and work with quick-start energy-saving effects [15].

Deeper insights on the process and driven-factors of household energy-saving intentions are necessary for energy-conservation policymaking and household energy-efficient behavior promotion. The Theory of Planned Behavior (TPB) is one of the most used models for prediction of pro-environmental behaviors. Many previous studies also employed the TPB model to predict or to explain household energy-saving behavior [16–19]. The TPB model suggests that occupants' intention to perform a specific behavior is driven by three psychological predictors: (1) positive evaluation of the action (attitude); (2) social pressure encouraging the behavior (subjective norm) and (3) perceived ease of performing the behavior (perceived behavioral control). However, some researchers argue that the TPB framework less considers the interactions between the three predictors and the contribution of demographic factors to behaviors [20,21] while only a few studies discussed the effects of the above factors on household energy-saving intention or behaviors. Moreover, although many empirical works have focused on energy-saving behavior in Chinese households, only a few of them paid attention to northwest China, a large (3.2 Mkm^2) but less developed area.

This paper aims to investigate how interactive effects of TPB predictors, as well as three socio-demographic factors (including income, education, and house ownership), contribute to household energy-conservation intention. The study is based on an empirical study covering 207 families (with 553 residents) in Xi'an, the most populous in northwest China. The study first reviews previous and published studies discussing interactions between the three predictors and proposes the research models. Then, the paper detailly presents the design of the field experiment and data collection process. The paper also conducts data analysis with structural equation modeling (SEM) and discusses the findings, limitations of the study, as well as the directions of further studies. The study also collects subjective feedbacks from respondents and qualitatively analyzes the factors influencing their household energy-saving behaviors. This study advances the current research by discussing the effects of socio-demographic and psychological factors on household energy-saving intention in northwest China. In addition, the findings would be conducive to building operators and policymakers to promote energy-conservation behaviors and to mitigate severe energy overuse problem in residential buildings.

2. Literature Review

2.1. The TPB

The TPB is a classic model for explaining or predicting behavior and behavioral change [22]. The TPB model suggests the proximal and immediate determinant of an individual's specific behavior is behavioral intention (BI), which reflects an indication of an individual's readiness to perform a given action. The model also indicates that the BI towards one specific behavior is a function of three predictors, namely attitude (ATT), subjective norms (SN), and perceived behavioral control (PBC). The TPB effectively covers an individual's social and non-volitional behavior and presents an adequate performance in terms of explanatory power [23,24]. Therefore, the model has been widely employed in studies on various pro-environmental behaviors, including energy conservation [16,19,25], water conservation [26–28], waste recycling and management [29,30], green hotel or office occupation [31,32].

The TPB was developed based on the Theory of Reasoned Action (TRA) [22,33]. Fishbein and Ajzen proposed the TRA model to explain the behavioral process [34]. The TRA model only considered two anthropogenic factors contributing to BI: attitude and SNs. Attitude reflects an individual's favorable or unfavorable evaluation of conducting a specific behavior and entails a consideration of the outcomes of performing such a behavior [18]. Generally, attitude is determined by accessible beliefs: the subjective probability that the specific behavior will produce a certain outcome [34]. Abrahamse and Steg (2009) noted that factors such as financial and time cost may significantly stimulate behavioral attitude. For example, residents with stronger pro-environmental attitudes tend to perform household pro-environmental behaviors, such as waste recycling and water saving, for environmental protection [35]. Some current research works found that attitude was significant or even the most significant contributor to pro-environmental intention. For instance, Paul et al. (2016) indicate that the most influential psychological factor encouraging consumers to purchase green products is their attitude towards environmental protection [36]. This paper considers the subjective expectation in financial benefits as a factor contributing to household energy-saving attitude, while most of previous studies treat it as an independent factor [37,38].

SN refers to the external pressure encouraging or discouraging the behavior. The pressure generally comes from influential people, such as families, co-workers, or friends. For examples, some studies suggest that employees may be discouraged to set the air-conditioning temperature higher in summer considering that their co-workers' feeling in the office [39,40]. In addition, some studies also found that hotel guests with stronger SNs are more likely to reuse towels and to reduce waste of water [28,41]. However, many researchers indicated that SN was the weakest predictor among two TRA factors or even all three TPB factors [30,36]. Some studies even found the effect of SN disappears, considering other factors [37,42].

However, behavior intention not only depends on personal willingness but also related to "non-will" factors (e.g., budget, knowledge, and time) in practice, which limits the explanatory power of TRA model [22,33,43]. Therefore, Ajzen (1985) further developed the concept of TRA and proposed a new model (i.e., TPB) by adding another variable, PBC [44]. PBC refers to the perceived ease or difficulty of performing the behavior, which is determined by external conditions such as the availability of facilities and one's perceived ability. For example, householders would be less likely to reduce energy use if they are not confident of keeping these behaviors. Some studies believe that PBC is the most significant contributor to behaviors [42,45]. However, many other research works hold different views [17,19,39]. For instance, Chen et al. (2014) even found that the effect of PBC on BI was less significant [23].

The study employs the TPB model (Figure 1) as Model 1. Based on the TPB model, this paper proposes the following hypothesis:

Hypothesis 1 (H1). *Behavioral attitude (ATT) toward household energy-saving positively affects household energy-saving intention*;

Hypothesis 2 (H2). *Subjective norms (SN) positively affect household energy-saving intention*;

Hypothesis 3 (H3). *Perceived behavioral control (PBC) positively affects household energy-saving intention*.

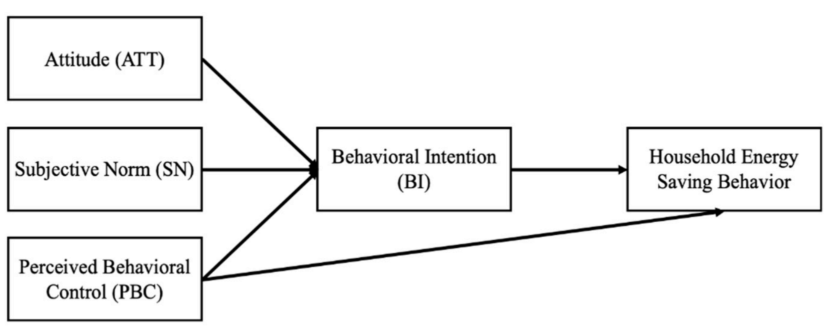

Figure 1. The Theory of Planned Behavior (TPB) Framework (Model 1).

2.2. Interactions between TPB Predictors

Previous empirical studies have discussed the direct relationships between household energy-saving intention and the TPB predictors. However, interaction effects between TPB predictors on pro-environmental intention or behaviors, including household energy-saving, could be more complicated than what the literature has suggested [45]. Only a few studies paid attention to this research gap. For example, Ru et al. (2018) found that the combined effect between PBC and subjective norms (SN × PBC) on household energy-saving intention is significant [42].

Some research works pointed out that the interaction between attitude and subjective (ATT × SN) may affect pro-environmental BI. For example, Wan et al. (2017a) found a significant relationship between ATT × SN and recycling intention [46]. Srivastava and Mahendar (2018) also presented that ATT × SN strongly related to households' adoption intention of green energy product [47]. Hukkelberg et al. (2014) indicated that the effect of ATT × SN on quitting smoking intention is significant as well [48]. Moreover, existing studies also suggest that the combined effect between subjective norms and PBC (SN × PBC) can be another significant predictor. For example, some studies suggested the effects of SN × PBC on occupants' electric vehicles purchase intention and green space use intention, respectively [49]. A few studies also supported that the interactive effect of attitude and PBC (ATT × PBC) on intention is significant. For example, Lynne et al. (1995)'s study demonstrated that both ATT × SN and ATT × PBC have a significant impact on farmers' conservation technology adoption intention [50]. Hukkelberg et al. (2014) and Kothe and Mullan (2015) also supported that ATT × PBC positively and significantly contribute to intention ([48,51]). The current study attempts to explore the interactive effects between three TPB predictors on household energy-saving intention.

The study proposes the following hypothesis and presents them in Figure 2 (Model 2):

Hypothesis 4 (H4). *The interaction between behavioral attitude toward household energy-saving and subjective norms (ATT × SN) significantly affects household energy-saving intention*;

Hypothesis 5 (H5). *The interaction between subjective norms and perceived behavioral control (SN × PBC) significantly affects household energy-saving intention*;

Hypothesis 6 (H6). *The interaction between behavioral attitude and perceived behavioral control (ATT × PBC) significantly affects household energy-saving intention.*

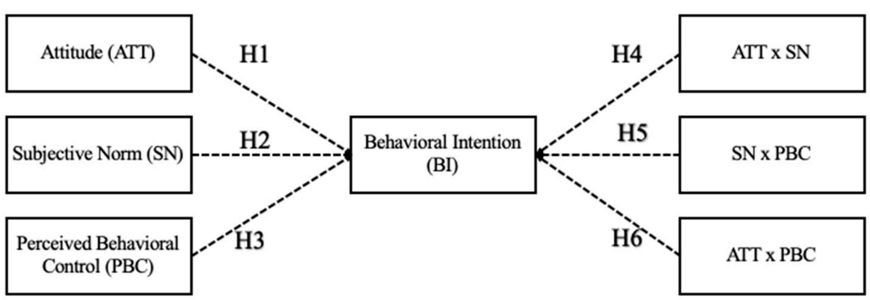

Figure 2. The Research Model (Model 2).

2.3. Socio-Demographic Factors

In addition to psychological factors, occupants' household energy-saving intention is also dependent on socio-demographic factors, such as income and education [52]. Differences between energy consumption in identical residential units are significant considering socio-demographic factors. However, the effects of demographic and building-related factors have rarely received attention in previous studies. In particular, the correlations between one's household energy-saving intention and three external factors (i.e., building ownership, household income, and education) are still unclear.

Building ownership (i.e., rented vs. self-owned) may affect energy-saving intention and behaviors by influencing occupants' ability to adapt the energy-efficient measure. Some studies found that homeowners tend to employ environmental-friendly measure (Yu et al., 2011). Barr et al. (2005) argued that house ownership promotes household energy-saving behaviors by enhancing the sense of personal control and belonging of residents. Frederiks et al. (2015) also supported that residents with home ownership may hold longer tenure and thus, may receive a higher return on energy efficiency investments than renters [52]. Another potential reason is that homeowners are less price-sensitive and have better financial security than renters. However, Rehdanz (2007) found that homeowners even consume more energy than renters [53]. Education may also affect household energy-saving intention or behavior [54].

Most existing studies support that the education level may promote energy conversation or energy efficiency investments [55–59]. Mills and Schleich (2010) found that higher education level associated with the adoption of energy-efficient measure and household energy-saving practice [58]. In particular, residents with a university education are more likely to point out the importance of energy conservation for environmental protection rather than financial reasons [59]. Wan et al. (2018) also found that people with higher education level tend to have stronger recycling intention [60]. Only a few studies found that the correlation between education and energy-saving intention is insignificant [42,61].

Household income is another socio-demographic factor that potentially impacts energy-conservation intention and behavior. Only a few studies focused on the effect of household income on household energy-saving intention and how income factor contribute to energy-saving intention is controversial. Many studies note that residents with higher income tend to consume more energy [61,62]. However, there is also evidence showing that households with higher income are more likely to invest in the energy-efficient measure, participate in the energy-saving scheme, or be willing to perform household energy-saving behaviors [52,57]. Thus, an investigation on the relationship between household income level and household energy-saving intention is necessary.

Therefore, this study puts forward the following hypothesis:

Hypothesis 7 (H7). *The building ownership positively affects household energy-saving intention*;

Hypothesis 8 (H8). *The education level positively affects household energy-saving intention*;

Hypothesis 9 (H9). *The household income positively affects household energy-saving intention.*

A research model (Model 3) proposed, according to Hypothesis 1 to Hypothesis 9 is shown in Figure 3.

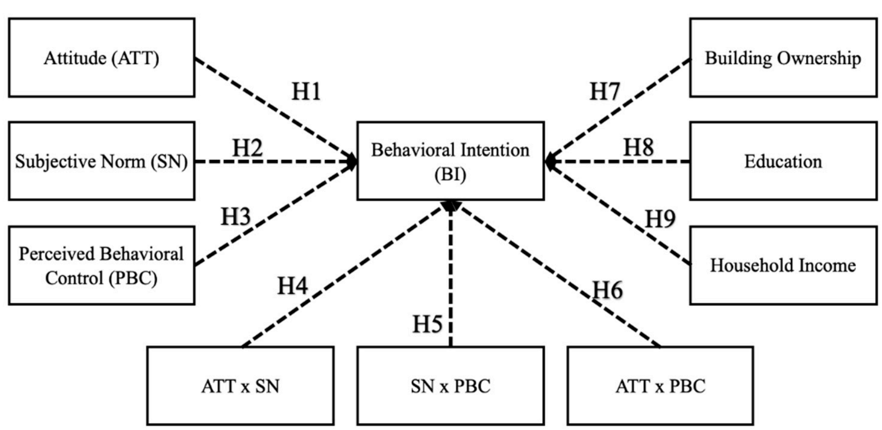

Figure 3. The Research Model (Model 3).

3. Methodology

3.1. Measure

This research conducted a field experiment in Xi'an, the most populous but typical city in northwest China. The experiment focused on households in three residential communities in Beilin and Yanta District of Xi'an, Shaanxi Province, China. Both two districts are in urban area. First, the study conducted a small-scale pilot test with N = 15. The researchers revised some questions and wordings in the questionnaire according to the comments and suggestions provided by participants. Then, the study employed a two-stage cluster sampling method [63], which is widely employed in social science field [64]. The samples were taken from the urban areas that have similar demographic profile of residents to reflect the common housing situation in Xi'an city. Collaborating with the local neighborhood committees, the researchers held a series of household energy-saving workshops in the three local communities on December 2018, where the researchers called for households to participate in the survey. When a required number of households were signed up, the researchers randomly selected 250 qualified households that have lived in the three assigned communities for at least one year (i.e., 12 months). The researchers invited those family members who generally consume most time at their homes to fill out the questionnaires because they are expected to be more familiar with their household energy consumption status.

The researchers distributed the uniform online questionnaires by WeChat, which is one of the most prevalent social software in mainland China [35,65]. Evidence supports that WeChat is an adequate platform to distribute energy-saving questionnaires or interventions [66,67]. The research team offered vouchers to all participants who successfully complete the questionnaire and provide valid feedback. The study collected 207 (i.e., 82.8%) valid feedbacks covering 553 residents (272 female and 281 male) from the selected families. Moreover, the researchers also encouraged all participants to write down at most three elements that promoting and obstructing their household energy-saving behaviors respectively and collected 453 positive items and 421 negative items. The average age of responding residents is 36.44 and 138 (i.e., 66.7%) participating households are local families (i.e., holding local Hukous). The detailed respondent profile is in Table 1.

Table 1. Respondent Profile.

Demographic Variable		***N***	**%**	**Mean**
Gender	Male	281	50.8%	N/A
	Female	272	49.2%	
Age (Year)	Above 60	72	13.0%	36.44
	45–60	116	21.0%	
	30–44	198	35.8%	
	15–29	97	17.5%	
	Below 15	70	12.7%	
Highest Education level in household	PhD degree or above (1)	9	0.4%	3.18
	Master's degree or equivalent (2)	23	11.1%	
	Bachelor's degree or equivalent (3)	94	45.4%	
	Polytechnic degree or equivalent (4)	59	28.5%	
	Highschool or equivalent (5)	17	8.2%	
	Junior High school and below (6)	5	2.4%	
Family Income (per month)	More than CN¥ * 30k (1)	10	4.8%	3.85
	CN¥20k to CN¥30k (2)	26	12.6%	
	CN¥12k to CN¥20k (3)	52	25.1%	
	CN¥8k to CN¥12k (4)	48	23.2%	
	CN¥4k to CN¥8k (5)	52	25.1%	
	Less than CN¥4k (6)	7	3.4%	
	Not Applicable (7)	12	5.8%	

CN¥ refers to 1: Chinese Yuan (approximately 1 Chinese Yuan equal to 0.15 USD).

3.2. Questionnaire Design

The researchers distributed a uniform online questionnaire with two sections. The first section employs a 16-item scale to residents (see Table 2). The questions covered four constructs: attitude (ATT), SN, PBC, and household energy-saving intention (i.e., BI). The questionnaire design learned from Ru et al. (2018) and Webb et al. (2013)'s works [17] Each construct includes four questions on a five-point scale, where "1" indicated the most negative view (i.e., strongly disagree) while "5" meant the most favorable view (i.e., strongly agree). The second part included questions about socio-demographic information. All items were designed in Chinese and were then backtranslated and revised for cultural adaptation before distribution.

The questionnaire emphasized the definition of household energy-saving behaviors: "the household behaviors aiming at reducing energy consumption or enhancing energy efficiency." In addition, the researchers also provided participants with four examples of household energy-conservation behaviors: (1) Turning off the light before you leave; (2) Setting your air-conditioning/heating system below 20 °C; (3) Control showering time and try to avoid running deep shower, and; (4) Heating enough water without too much unused. The questionnaire presented the instructions that "there are no right or wrong answers; only your personal opinions matter" at both cover letter and each section to minimize the impact of social desirability.

Table 2. The 16-item Scale Questionnaire Employed in this Study.

Item	Constructs	Code
I can save money by performing energy-saving behaviors at home;	Attitude (ATT)	1
I can hardly benefit from my household energy-saving behaviors; (R *)		5
Household energy-saving behaviors are important for environmental protection;		9
I do not believe my behavior can significantly contribute to household energy conservation; (R *)		13
My families or roommates do not expect my household energy-saving behaviors; (R *)	Subjective Norms (SN)	2
My energy-saving behaviors are educational for the next generation;		6
My friends are less likely to praise me for my household energy-saving behaviors; (R *)		10
Others who are important to me expect my household energy-saving behaviors;		14
Household energy-saving behaviors are easy to perform;	PBC	3
I do not know how to save energy at home; (R *)		7
I have enough knowledge and skills to perform energy-saving behavior;		11
I always forget to preform energy-saving behaviors at home; (R *)		15
I am willing to perform energy-saving behaviors at home in the following week;	Energy-Saving Intention (I)	4
I am willing to think about whether my behaviors at home are energy-efficient in the following week;		8
I am willing to participate in the energy-saving scheme in the following week;		12
I am willing to talk to other family members about energy conservation in the following week;		16

R * refers to reversed question(s).

3.3. Data Analysis

This study employed structural equation modeling estimation (SEM) for quantitative data analysis. SEM is a generalization, integration, and extension of simple techniques such as analysis of variance (ANOVA), multiple regression analysis, and factor analysis [68,69]. Therefore, SEM combines the advantages of factor analysis, path analysis, and multiple regression analysis so that the technique makes it possible to estimate the multiple and interrelated dependence in a single study. As a result, SEM enables researchers to answer a set of interrelated research questions in a single, systematic, and comprehensive analysis by modeling the relationships among multiple independent and dependent constructs simultaneously [68,70].

Moreover, SEM also allows researchers to simultaneously estimate the relationships between observed and unobserved variables and the relationships among unobserved variables and enables researchers to simultaneously include both continuous and categorical observed and latent variables [69]. Therefore, the technique is widely employed in behavioral sciences, and have been employed to analyze or to predict several pro-environmental behaviors [19], such as sustainable transportation [71], recycling behaviors [29]. According to Hair et al. (2011)'s thumb rule, the sample size for the SEM analysis is required to reach at least ten times larger than the number hypothesized relationships directed to a particular dependent variable. There are nine paths directed to the dependent variable (i.e., household energy-saving intention) in the current study. Therefore, the required minimum sample is 90, and the sample size of 207 is statistically adequate. The current study employs AMOS as a tool for SEM analysis. AMOS is a tool based on Microsoft Windows, which can run as a stand-alone program or an optional part of SPSS. In addition, the study analyzes the subjective feedback from respondents with keyword analysis, where the researchers categorize the feedbacks manually to further discuss the role of significant factors in promoting and obstructing household energy-saving intention.

4. Results and Analysis

4.1. Measurement Modeling

The SEM analysis includes two modeling steps: (1) measurement modeling, and; (2) structural modeling [35]. The measurement modeling evaluated the convergent validity (CV) as well as discriminant validity (DV) of the constructs. This process assesses whether the measurement items are statistically reliable and valid for structural modeling.

4.1.1. CV Assessment

The CV reflects the correlations between items in the same statistical element [72–74]. There are four criteria for the CV assessment:

(1) The factor loading (FL) of each item should be larger than 0.5;
(2) The average variance extracted (AVE) of each element should be larger than 0.5;
(3) The composite reliability of each element should be larger than 0.7;
(4) The Cronbach's alpha (α) of each element should be larger than 0.6.

The result of the assessment (Table 3) shows that all element employed in the current study adequately met the statistical requirements for CV.

Table 3. Convergent Validity Assessment Results.

Constructs	Item	FL	AVE	Composite Reliability	Cronbach's Alpha (α)
ATT	1	0.858	0.608	0.839	0.713
	5	0.936			
	9	0.887			
	13	0.784			
SN	2	0.900	0.630	0.871	0.818

	6	0.725			
	10	0.783			
	14	0.755			
PBC	3	0.800	0.523	0.773	0.856
	7	0.709			
	11	0.625			
	15	0.706			
BI	4	0.779	0.505	0.748	0.722
	8	0.793			
	12	0.862			
	16	0.802			

Note: ATT: Attitude towards Household Energy-Saving Behaviors; SN: Subjective Norms; PBC: Perceived Behavior Control; BI: Energy-Saving Behavioral Intention.

4.1.2. DV Assessment

The DV assessment is then conducted to avoid correlated items within different statistical elements. DV reflects the correlation between items in different statistical constructs. [75]. Heterotrait–Monotrait (HTMT) ratio is one of the widely employed methods for DV evaluation [74,75]. To fulfill the requirement, this study employs HTMT ratio assessment, where HTMT ratio of each construct should be not exceeding 0.9. The employed measurement presented adequate DV with results (Table 4).

Table 4. Heterotrait–Monotrait Ratio Assessment.

	ATT	**Building Ownership**	**Education**	**Income**	**PBC**	**SN**
ATT	/	/	/	/	/	/
Building Ownership	0.032	/	/	/	/	/
Education	0.064	0.007	/	/	/	/
Income	0.087	0.065	0.181	/	/	/
PBC	0.392	0.196	0.078	0.102	/	/
SN	0.495	0.144	0.06	0.022	0.304	/

4.2. Structural Modeling

In the second step, this study assessed the statistical significance of the hypothesized relationships specified in the three research models proposed in Section 2. Table 5 presents the results of the structural analysis.

Table 5. Structural Modeling Analysis Results.

	Model 1 β (*p*-Value)	**Model 2** β (*p*-Value)	**Model 3** β (*p*-Value)
H1: ATT -> BI	0.899 (***)	0.899 (***)	0.900 (***)
H2: SN -> BI	0.104 (#)	0.013 (0.495)	0.008 (0.634)
H3: PBC -> BI	0.191 (***)	0.251 (***)	0.258 (***)
H4: ATT × SN -> BI		0.186 (***)	0.169 (***)
H5: SN × PBC -> BI		−0.005 (0.782)	0.014 (0.371)
H6: ATT × PBC -> BI		−0.059 (***)	−0.101 (***)
H7: Building Ownership -> BI			−0.005 (0.776)
H8: Education -> BI			0.013 (0.420)
H9: Household Income -> BI			0.029 (0.069 #)

#: $p < 0.1$; ***: $p < 0.001$.

Model 1 shows that BI toward household energy-saving can be explained by three standard TPB predictors: attitude (β = 0.899, $p < 0.001$), SNs (β = 0.104, $p < 0.1$) and PBC (β = 0.191, $p < 0.001$). The result shows that residents' attitudes towards household energy conservation (with expected financial benefits) is the most significant factors contributing to household energy-saving intention. The significance of SNs is lower than expected. Figure 4 presents the standardized regression weights in Model 1.

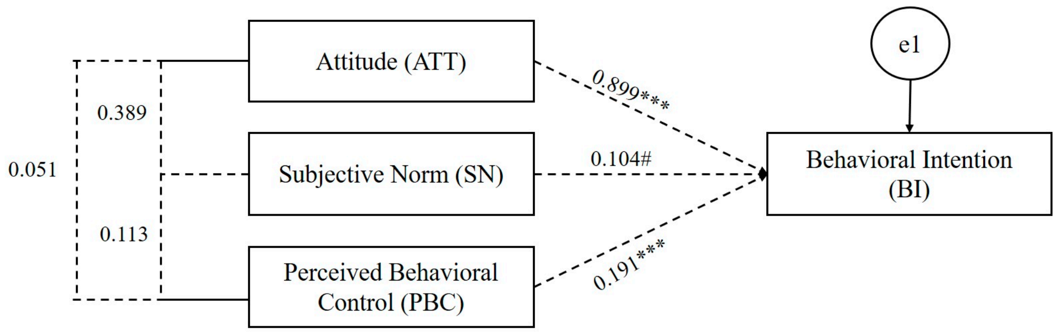

Figure 4. Standardized Regression Weights in Model 1.

Model 2 includes the interactive effects between three TPB predictors. By adding three variables, attitude (β = 0.899, $p < 0.001$) and PBC (β = 0.251, $p < 0.001$) are still significantly correlated with BI toward household energy-saving. However, the impact of SNs is less significant (β = 0.031; $p = 0.495$) while considering the combined effects. Thus, H2 is rejected. The results revealed that in addition to standard TPB predictors, ATT × SN ($p < 0.001$) is positively correlated with BI while the impact of ATT × PBC ($p < 0.001$) was negative, which supported H4 and H6, respectively. However, the β of ATT × PBC's effect was small (i.e., −0.059) suggesting its impact may be less important. The effect of SN × PBC on intention is not significant ($p = 0.782$). Hence, the H5 is rejected. Moreover, similar to that of Model 1, the correlation between attitude and the SN is strong in Model 2. The study presents the standardized regression weights in Model 2 in Figure 5.

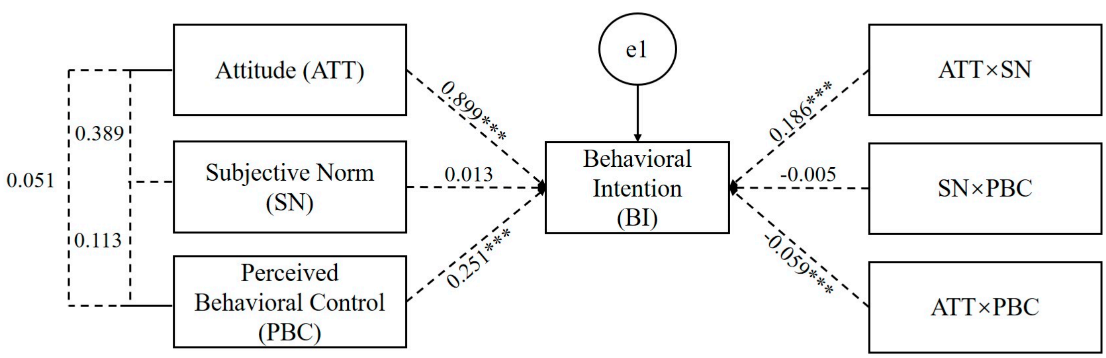

Figure 5. Standardized Regression Weights in Model 2.

Model 3 includes the interactive effects between three TPB predictors and three socio-demographic factors. Similar to that of Model 2, attitude (β = 0.900, $p < 0.001$) is the most significant contributor and the link between PBC and intention (β = 0.258, $p < 0.001$) is also significant, which supports H1 and H3. However, it is shown that SNs' effect is not significant (i.e., β = 0.008, $p = 0.634$). Thus, the result rejects H2. ATT × SN (β = 0.169; $p < 0.001$) is positively correlated with BI while the impact of ATT × PBC (β = −0.101; $p < 0.001$) is negative, which supports H4 and H6, respectively. The insignificant interactive effect between SN and PBC (i.e., $p = 0.371$) suggests that H5 is rejected. Two socio-demographic factors, building ownership and education, fail to present their correlation with household energy-saving intention. However, household income may have a positive correlation with the BI ($p = 0.069$), which supports H9 is with 90% confidence. Figure 6 presents the standardized regression weights in Model 3.

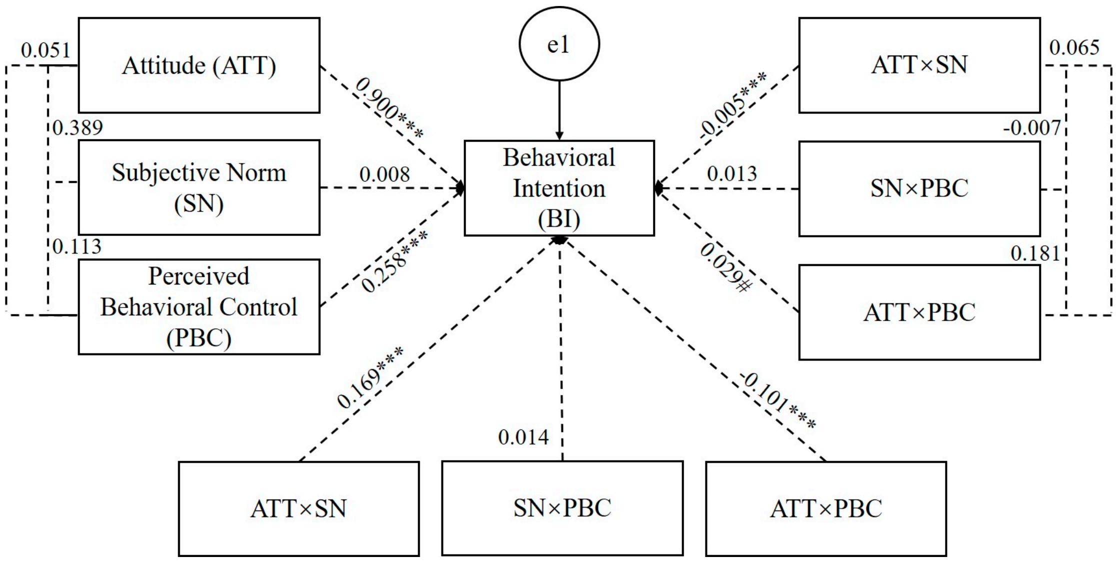

Figure 6. Standardized Regression Weights in Model 3.

4.3. Subjective Feedbacks

The study encouraged all participants to write down at most three positive factors promoting their household energy-saving as well as at most three obstructions. The researchers finally collected 453 valid positives and 421 negative responses from the residents. The researchers then conducted a keyword analysis and categorized the subjective feedbacks manually to discuss further the significant factors promoting and obstructing household energy-saving.

4.3.1. Positive Factors

The researchers categorized the positive subjective feedback from the residents into 14 items under seven directions including two attitude-related directions (i.e., personal and environmental benefits), one direction contributing to SNs (i.e., others' expectations), one PBC-related direction (i.e., convenience), and three directions that are less related to typical TPB factors (i.e., eco-education, moral norms, and past behavior). Table 6 presents the detailed result of keyword analysis for positive factors.

Table 6. The Keyword Analysis Result of Positive Factors.

Item	Num.	Freq. (%)	Directions (Num., Freq.)	TPB Factor (Num., Freq.)
Finance	119	26.27	Personal Benefits (166, 36.64%)	Attitude (considering expected financial benefits) (324, 71.52%)
Well-being and Comfort	19	4.19		
Health and Safety	15	3.31		
Sense of Achievement	13	2.87		
Environment and Eco-System Protection	74	16.34	Environmental Benefits (158, 34.88%)	
Resource Conservation	56	12.36		
Environmental Awareness	16	3.53		
Pollution Reduction	12	2.65		

Expectations of Public and Communities	16	3.53	Others' Expectations (27, 5.96%)	Subjective Norms (27, 5.96%)
Expectations of the Families and Offspring	11	2.43		
Convenience	30	6.62	Convenience (30, 6.62%)	PBC (30, 6.62%)
Environmental Education	20	4.42	Environmental Education (20, 4.42%)	Others (72, 15.89%)
Moral Responsibility	20	4.42	Moral Norms (20, 4.42%)	
Habits/Past Behavior	32	7.06	Past Behavior (32, 7.06%)	

The keyword analysis result shows that attitude (i.e., 71.52%) is the most important factor contributing to household energy-saving behavior. There are 166 (i.e., 36.64%) feedbacks related to personal benefits, making it the most significant direction. It seems that the respondents were more sensitive to quantizable interests such as finance (i.e., 119, 26.27%) rather than well-being and comfort (i.e., 19, 4.19%), health and safety (i.e., 15, 3.13%), and sense of achievement (i.e., 13, 2.87%). Many participants mentioned their household financial burden and noted that "saving money" was the most powerful reason to push them to save energy at home. Moreover, many responses (i.e., 158, 34.88%) were related to environmental benefits, where 74 (i.e., 16.34%) of them mentioned environmental protection and 56 (i.e., 12.36%) pointed out resource conservation.

The result also presented that subjective feedbacks related to SNs (i.e., 27, 5.96%) and PBC (i.e., 30, 6.62%) were less powerful than attitude. Only 11 respondents would save energy for the expectations of their family members or offshore. However, it is worth noting that there are many (i.e., 72, 15.89%) feedbacks related to eco-education, moral norms, and habits, rather than the typical TPB factors. In particular, the results show that 32 (i.e., 7.06%) mentioned that the positive role of habits while most of them are elderly residents.

4.3.2. Negative Factors

The study categorized the 421 negative items into six directions including one attitude-related direction (i.e., personal benefits), two subjective norms-related direction (i.e., families' expectations and social trend), one PBC-related direction (i.e., PBC) and two directions that are less related to typical TPB factors (i.e., external environment, and past behavior). The keyword analysis results of the negative factors is summarized in Table 7.

Table 7. The Keyword Analysis Result of Negative Factors.

Item	Num.	Freq. (%)	Directions (Num., Freq.)	TPB Factor (Num., Freq.)
Well-being and Comfort	98	23.28	Personal Benefits (157, 37.29%)	Attitude (considering expected financial benefits) (157, 37.29%)
Personal Reputation	31	7.36		
Finance	18	4.28		
Health/Safety/Disability	10	2.38		
Expectations of Family Members	40	9.50	Families' Expectations (40, 9.50%)	Subjective Norms (52, 12.35%)
Culture/Social Environment	12	2.85	Social Trend (12, 2.85%)	
Limited Time/Convenience	42	9.98	PBC (117, 27.79%)	PBC (117, 27.79%)
Poor Self-Control	25	5.94		
Limited Environmental Awareness	25	5.94		
Limited Environmental Knowledge	22	5.23		
Lack of Energy-Saving Plan	3	0.71		
Poor Design/Facility/Built Environment	52	12.35	External Environment (52, 12.35%)	Other (95, 22.56%)
Habits/Past Behavior	43	10.21	Past Behavior (43, 10.21%)	

Similar to positive feedbacks, household energy-saving attitude is the most important one among six directions, which covered 157 (i.e., 37.29%) responses. The result shows that 98 answers noted well-being and comfort as core obstruction of household energy conservation. Many of participants mentioned that their "laziness" obstructed their household energy conservation. Some people also mentioned that energy-saving behavior would reduce their thermal comfort or living quality. Eighteen respondents were noting that they could hardly obtain financial benefits from household energy conservation. Here provides typical feedback from one participant:

Xi'an has rapidly developed in recent decades and the average income increased a lot. Personally, my income can well cover my electricity bill… I can hardly save much money by saving energy at home. Thus, I never waste my time on those (household energy-saving) behaviors.

Moreover, some people (i.e., 31, 7.36%) believed that personal reputation was one of the core obstructions of their household energy-saving. The result shows that a few residents kept high-power electrical appliances on to avoid losing faces. Here provides typical feedback from one participant:

I want to turn off the air-conditioning system at home. But if I perform those behaviors, my parents and children might be worried about the financial condition of the family. I think I must keep their confidence… I just don't want to lose my face in front of my families and friends.

It seems that PBC-related directions (i.e., 117, 27.79%) also play an important role in negative factors on household energy conservation. The result shows that 42 (i.e., 9.98%) feedback noted that limited time was a core obstruction of household energy-saving behavior. Many respondents also believed that poor self-control and lack of environmental awareness negatively impacted their household energy conservation. Moreover, there were 40 (i.e., 9.50%) feedbacks related to expectations of family members and 12 feedbacks related to social trends or culture. In addition to the TPB-related directions, the respondents also mentioned that three factors obstruct their household energy-saving behaviors: poor building design or built environment (i.e., 52, 12.35%), and past behaviors (i.e., 43, 10.21%).

5. Discussion

The SEM analysis shows that the coefficient of attitude with expected financial benefits is 0.899, which is extremely higher than that of most previous studies (i.e., lower than 0.6) [76]. The result suggests that attitude is the most significant contributor to household energy-saving intention, which is in line with most of the previous studies [31,77]. Additionally, the qualitative analysis result also supports the above finding and further points out the important attitude-related factors: personal interests and environmental benefits. In particular, the researchers also noticed that the respondents paid attention to the environmental benefits from their household energy conservation, which reflects the strong environmental awareness of residents. Moreover, the researchers found that residents were more sensitive to financial benefits than those in the coastal areas, which is in line with a previous study on energy-saving intentions in low-income households in the USA [37]. The finding might be further explained by the income gap between east and west China. Although the expected financial benefit seems be important to household energy-saving intention, the qualitative analysis result is in line with Bergquist et al. (2019) and De Dominicis et al. (2019), who noted that social motives are more influential in pro-environmental intentions than financial motives [78,79]. Therefore, policymakers may consider encouraging household energy conservation with monetary benefits. For example, some northwestern cities have employed tiered electricity pricing system for the residential sector and received remarkable energy-saving results [80]. Furthermore, smart electricity meters providing real-time energy consumption feedback and their electricity bills may positively contribute to the residents' concerns about household energy expenditure [81,82].

The significance between SNs and intention is lower than expected, which is similar to other two Chinese studies [83,84]. This finding is also supported by the qualitative analysis result, where items related to SNs only accounts for 5.96% and 12.35% in positive and negative factors, respectively. According to Prud'homme and Raymond (2013), individuals with higher education level are more likely to perform sustainable behaviors due to their environmental concerns rather than others' evaluation [85]. The average education level of the participants in this study is higher than the average level in Xi'an: The percentage of residents with a bachelor's degree or equivalent in Xi'an is 26.8%, while that of the participants is 56.9%. This may partially explain the unusual finding. In addition, the expectation of other people may less influence participants' behaviors at home. A previous study showed that some residents are psychologically conflicted or even rebellious about outside pressure and tend to respond to negative energy use behaviors at home [86]. Therefore, some residents may only perform energy-conservation behaviors in public areas to show their positive attitude towards environmental protection and to avoid losing face. However, this motivation may decrease at home.

The quantitative analysis suggests that PBC is another effective factor to explain household energy-saving intention. Botetzagias et al. (2015) and Ru et al. (2018) also draw similar conclusions, which supports the above finding. In addition, the qualitative analysis shows the remarkable roles of the PBC-related items as negative factors in the energy-saving behavioral process. The subjective feedback further reflects residents' not confidence in their environmental knowledge and reveals some misconceptions about household energy-saving behavior among residents. Accordingly, further energy-saving programs and environmental education should detail the conception of energy-saving behaviors and break the dogma that those behaviors are "complex" and "time-consuming" with straightforward tips and demonstrations [87,88]. Moreover, a few feedbacks mentioned that unsatisfactory building design and built environment increase the difficulty of their energy-saving behaviors. Further buildings should well consider the man-machine relationship in their design, especially the accessibility of the disabilities.

The study also discussed the role of interactions between TPB factors in the energy-saving behavioral process. It is worth noting that when taking the interactive effects into account, the SN's contribution becomes less significant, which is in line with [42]. However, the SEM analysis result shows that interaction between attitude and SN (i.e., ATT × SN) positively correlated with household energy-saving intention. The analysis results in Wan et al. (2017)'s study also support the above finding [46]. The finding suggests that high SNs might not be compulsory for those occupants with high household energy-saving attitude to achieve a strong energy-saving intention. Similarly, residents with strong household energy-saving intention might only have strong SNs. Therefore, local governments and environmental organizations may invite celebrities and make use of their remarkable social influence to propagandize energy-saving behaviors. Those propagandas would present the social trend of household energy conservation to the public and to enhance the energy-saving intentions of those with lower energy-saving attitudes. Moreover, the study also finds that the combined effect of attitude and PBC (i.e., ATT × PBC) on intention is adverse. This result indicates that higher PBC may weaken the household energy-saving intention promoted by a strong attitude. However, this combined effect and its contribution to energy-saving intention are relatively small.

In addition to psychological factors, the SEM analysis result shows that household income may have a positive correlation between BI, which means that families with higher income tend to have greater household energy-saving intention. However, some previous studies draw the opposite conclusion: families with less income are more likely to perform sustainable behaviors to reduce their living cost [55,56]. The researchers attempt to explain the unusual funding with the following two possible reasons. The first potential explanation of the current result is that high-income families may have a better understanding of energy-saving and its importance in environmental protection. Therefore, families with higher income may be forced by a higher attitude towards energy-saving intention. Moreover, high-income families may have the ability to purchase energy-efficient equipment and to employ designs with a better man-machine relationship, which makes their energy-saving behavior easier than others and further enhances the PBC of high-income households.

The study also exists some limitations. First, some items in the respondent profile of this study do not well meet the socio-demographic characteristics of the city. In particular, the bachelor's degree or equivalents holders account for 56.9% in the study while the average level of Xi'an is only 26.88%. A potential reason is that the study only discussed the household energy-saving behaviors of residents in the urban area and all respondents in this study were living in the urban area. However, there are 2.6 million (i.e., 25.99%) and 590 million (i.e., 41.48%) residents living in rural areas in Xi'an and mainland China, respectively. The researchers suggest that further studies would benefit from paying more attention to the rural population in China. Secondly, the researchers invited the family members who spent most time at home to fill out the questionnaire. Although these respondents are expected to be more familiar with their household energy consumption situations, their feedback may potentially affect the analysis results as well. Third, the study includes the expected financial benefit as one of contributors to attitude rather than an independent factor contributing to household energy-saving intention, which leads to an extremely high coefficient of attitude. The authors do hope that further studies can benefit from separately discussing the relative importance of financial and social motives and deeply investigating the role of expected financial benefit playing in pro-environmental behavioral process with novel theoretical frameworks.

6. Conclusions

This study distributed uniform questionnaires to 207 households in Xi'an, China. The research examines how three standard TPB predictors, their interactive effects and three socio-demographic factors (i.e., house ownership, education and household income) contribute to household energy-saving intention. The results revealed that attitude and PBC play significant roles in the household energy-saving behavioral process, while the significance of SNs is lower than expected. In addition, the two interaction terms (i.e., ATT × SN and ATT × PBC) significantly influenced household energy-saving BI. The study also implies that household income may positively associate with energy-saving BI at home. However, the study also has some limitations. The researchers recommend further studies to employ larger samples and to reduce the impact of cultural and language differences. Also, further studies may benefit from considering residents in rural areas. This paper contributes to the energy-saving behavior literature by expounding the nature and the roles of interactive effects of psychological factors as well as socio-demographic factors. The model would not only provide a reference for further studies but also be conducive to governments and environmental protection organizations in the areas facing severe household energy overuse problems in northwest China. Moreover, the findings may contribute to a more accurate building energy simulation and modeling.

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References

1. Chen, S.; Li, N.; Guan, J.; Xie, Y.; Sun, F.; Ni, J. A statistical method to investigate national energy consumption in the residential building sector of China. *Energy Build.* **2008**, *40*, 654–665.
2. Zhang, Y.; He, C.Q.; Tang, B.J.; Wei, Y.M. China's energy consumption in the building sector: A life cycle approach. *Energy Build.* **2015**, *94*, 240–251.
3. Nejat, P.; Jomehzadeh, F.; Taheri, M.M.; Gohari, M.; Majid, M.Z.A. A global review of energy consumption, CO_2 emissions and policy in the residential sector (with an overview of the top ten CO_2 emitting countries). *Renew. Sustain. Energy Rev.* **2015**, *43*, 843–862.
4. Amasyali, K.; El-Gohary, N.M. A review of data-driven building energy consumption prediction studies. *Renew. Sustain. Energy Rev.* **2018**, *81*, 1192–1205.
5. Virote, J.; Neves-Silva, R. Stochastic models for building energy prediction based on occupant behavior assessment. *Energy Build.* **2012**, *53*, 183–193.

6. Zhang, S.; Wang, Q.; Hu, L.; Shi, W.; Qu, M. A Feasibility Study on the Waste-to-Biogas SOFC-Based Multi-Generation with Energy Storage System for Building Applications in China. *IOP Conf. Ser. Earth Environ. Sci.* **2019**, *290*, 012110.
7. Zhao, X.Y.; Cheng, H.H.; Zhao, H.L.; Jiang, L.; Xue, B. Survey on the households' energy-saving behaviors and influencing factors in the rural loess hilly region of China. *J. Clean. Prod.* **2019**, *230*, 547–556.
8. Kassai, M.; Poleczky, L.; Al-Hyari, L.; Kajtar, L.; Nyers, J. Investigation of the Energy Recovery Potentials in Ventilation Systems in Different Climates. *Facta Univ. Ser. Mech. Eng.* **2018**, *16*, 203–217.
9. Gaetani, I.; Hoes, P.J.; Hensen, J.L. Occupant behavior in building energy simulation: Towards a fit-for-purpose modeling strategy. *Energy Build.* **2016**, *121*, 188–204.
10. Wang, Q.; Wei, H.H.; Xu, Q.J.S. A Solid Oxide Fuel Cell (SOFC)-Based Biogas-from-Waste Generation System for Residential Buildings in China: A Feasibility Study. *Sustainability* **2018**, *10*, 2395.
11. Shen, M.; Cui, Q.; Fu, L. Personality traits and energy conservation. *Energy Policy* **2015**, *85*, 322–334.
12. Vasseur, V.; Marique, A.F. Households' Willingness to Adopt Technological and Behavioral Energy Savings Measures: An Empirical Study in The Netherlands. *Energies* **2019**, *12*, 4294.
13. Kassai, M.; Ge, G.; Simonson, C.J. Dehumidification performance investigation of run-around membrane energy exchanger system. *Therm. Sci.* **2016**, *20*, 1927–1938.
14. Vassileva, I.; Dahlquist, E.; Wallin, F.; Campillo, J. Energy consumption feedback devices' impact evaluation on domestic energy use. *Appl. Energy* **2013**, *106*, 314–320.
15. Ouyang, J.L.; Gao, J.L.; Luo, X.Y.; Ge, J.; Kazunori, H. A study on the relationship between household lifestyles and energy consumption of residential buildings in China. *J. South China Univ. Technol. Nat. Sci. Ed.* **2007**, *35*, 171–174.
16. Menezes, A.C., Tetlow, R., Beaman, C.P., Cripps, A., Bouchlaghem, D, & Buswell, R. Assessing the Impact of Occupant Behaviour on Electricity Consumption for Lighting and Small Power in Office Buildings. In Proceedings on the International Conference of Architecture Engineering and Construction (AEC2012), Sao Paulo, Brazil, 15–17 August 2012.
17. Webb, D.; Soutar, G.N.; Mazzarol, T.; Saldaris, P. Self-determination theory and consumer behavioural change: Evidence from a household energy-saving behaviour study. *J. Environ. Psychol.* **2013**, *35*, 59–66.
18. Hai, M.A.; Moula, M.M.E.; Seppälä, U. Results of intention-behaviour gap for solar energy in regular residential buildings in Finland. *Int. J. Sustain. Built Environ.* **2017**, *6*, 317–329.
19. Chen, M.F. Extending the theory of planned behavior model to explain people's energy savings and carbon reduction behavioral intentions to mitigate climate change in Taiwan–moral obligation matters. *J. Clean. Prod.* **2016**, *112*, 1746–1753.
20. Smith, J.R.; Terry, D.J.; Manstead, A.S.; Louis, W.R.; Kotterman, D.; Wolfs, J. Interaction effects in the theory of planned behavior: The interplay of self-identity and past behavior. *J. Appl. Soc. Psychol.* **2007**, *37*, 2726–2750.
21. Conner, M.; McMillan, B. Interaction effects in the theory of planned behaviour: Studying cannabis use. *Br. J. Soc. Psychol.* **1999**, *38*, 195–222.
22. Ajzen, I. The theory of planned behavior. *Organ. Behav. Hum. Decis. Process.* **1991**, *50*, 179–211.
23. Hassan, L.M.; Shiu, E.; Parry, S. Addressing the cross-country applicability of the theory of planned behaviour (TPB): A structured review of multi-country TPB studies. *J. Consum. Behav.* **2016**, *15*, 72–86.
24. Chen, C.C. The exploration on network behaviors by using the models of Theory of planned behaviors (TPB), Technology acceptance model (TAM) and C-TAM-TPB. *Afr. J. Bus. Manag.* **2013**, *7*, 2976–2984.
25. Wang, Z.; Zhang, B.; Li, G. Determinants of energy-saving behavioral intention among residents in Beijing: Extending the theory of planned behavior. *J. Renew. Sustain. Energy* **2014**, *6*, 053127.
26. Lowe, B.; Lynch, D.; Lowe, J. Reducing household water consumption: A social marketing approach. *J. Mark. Manag.* **2015**, *31*, 378–408.
27. Wells, V.K.; Taheri, B.; Gregory-Smith, D.; Manika, D. The role of generativity and attitudes on employees home and workplace water and energy saving behaviours. *Tour. Manag.* **2016**, *56*, 63–74.
28. Han, H.; Hyun, S.S. What influences water conservation and towel reuse practices of hotel guests? *Tour. Manag.* **2018**, *64*, 87–97.
29. Wan, C.; Shen, G.Q.; Yu, A. The role of perceived effectiveness of policy measures in predicting recycling behaviour in Hong Kong. *Resour. Conserv. Recycl.* **2014**, *83*, 141–151.
30. Oztekin, C.; Teksöz, G.; Pamuk, S.; Sahin, E.; Kilic, D.S. Gender perspective on the factors predicting recycling behavior: Implications from the theory of planned behavior. *Waste Manag.* **2017**, *62*, 290–302.

31. Han, H.; Kim, Y. An investigation of green hotel customers' decision formation: Developing an extended model of the theory of planned behavior. *Int. J. Hosp. Manag.* **2010**, *29*, 659–668.
32. Malkani, A.; Starik, M. The green building technology model: An approach to understanding the adoption of green office buildings. *J. Sustain. Real Estate* **2014**, *5*, 131–148.
33. Chang, M.K. Predicting unethical behavior: A comparison of the theory of reasoned action and the theory of planned behavior. *J. Bus. Ethics* **1998**, *17*, 1825–1834.
34. Fishbein, M.; Ajzen, I. *Belief, Attitude, Intention, and Behavior: An Introduction to Theory and Research*; Addison-Wesley: Reading, MA, USA, 1975.
35. Abrahamse, W.; Steg, L. How do socio-demographic and psychological factors relate to households' direct and indirect energy use and savings? *J. Econ. Psychol.* **2009**, *30*, 711–720.
36. Paul, J.; Modi, A.; Patel, J. Predicting green product consumption using theory of planned behavior and reasoned action. *J. Retail. Consum. Serv.* **2016**, *29*, 123–134.
37. Chen, C.; Xu, X.; Day, J. Thermal comfort or money saving? Exploring intentions to conserve energy among low-income households in the United States. *Energy Res. Soc. Sci.* **2017**, *26*, 61–71.
38. Wang, B.; Wang, X.; Guo, D.; Zhang, B.; Wang, Z. Analysis of factors influencing residents' habitual energy-saving behaviour based on NAM and TPB models: Egoism or altruism? *Energy Policy* **2018**, *116*, 68–77.
39. Tetlow, R.M.; van Dronkelaar, C.; Beaman, C.P.; Elmualim, A.A.; Couling, K. Identifying behavioural predictors of small power electricity consumption in office buildings. *Build. Environ.* **2015**, *92*, 75–85.
40. Lo, S.H.; Peters, G.J.Y.; van Breukelen, G.J.; Kok, G. Only reasoned action? An interorganizational study of energy-saving behaviors in office buildings. *Energy Effic.* **2014**, *7*, 761–775.
41. Terrier, L.; Marfaing, B. Using social norms and commitment to promote pro-environmental behavior among hotel guests. *J. Environ. Psychol.* **2015**, *44*, 10–15.
42. Ru, X.; Wang, S.; Yan, S. Exploring the effects of normative factors and perceived behavioral control on individual's energy-saving intention: An empirical study in eastern China. *Resour. Conserv. Recycl.* **2018**, *134*, 91–99.
43. Madden, T.J.; Ellen, P.S.; Ajzen, I. A comparison of the theory of planned behavior and the theory of reasoned action. *Personal. Soc. Psychol. Bull.* **1992**, *18*, 3–9.
44. Ajzen, I. From intentions to actions: A theory of planned behavior. In *Action Control*; Springer: Berlin Heidelberg, Germany, 1985; pp. 11–39.
45. Botetzagias, I.; Dima, A.F.; Malesios, C. Extending the theory of planned behavior in the context of recycling: The role of moral norms and of demographic predictors. *Resour. Conserv. Recycl.* **2015**, *95*, 58–67.
46. Wan, C.; Shen, G.Q.; Choi, S. A review on political factors influencing public support for urban environmental policy. *Environ. Sci. Policy* **2017**, *75*, 70–80.
47. Srivastava, C.; Mahendar, G. Intention to adopt sustainable energy: Applying the theory of planned behaviour framework. *Indian J. Mark.* **2018**, *49*, 20–33.
48. Hukkelberg, S.; Hagtvet, K.; Kovac, V. Latent interaction effects in the theory of planned behaviour applied to quitting smoking. *Br. J. Health Psychol.* **2014**, *19*, 83–100.
49. Wan, C.; Shen, G.Q.; Choi, S. Experiential and instrumental attitudes: Interaction effect of attitude and subjective norm on recycling intention. *J. Environ. Psychol.* **2017**, *50*, 69–79.
50. Lynne, G.D.; Casey, C.F.; Hodges, A.; Rahmani, M. Conservation technology adoption decisions and the theory of planned behavior. *J. Econ. Psychol.* **1995**, *16*, 581–598.
51. Kothe, E.; Mullan, B. Interaction effects in the theory of planned behaviour: Predicting fruit and vegetable consumption in three prospective cohorts. *Br. J. Health Psychol.* **2015**, *20*, 549–562.
52. Shi, H.; Wang, S.; Zhao, D. Exploring urban resident's vehicular PM2. 5 reduction behavior intention: An application of the extended theory of planned behavior. *J. Clean. Prod.* **2017**, *147*, 603–613.
53. Frederiks, E.R.; Stenner, K.; Hobman, E.V. Household energy use: Applying behavioural economics to understand consumer decision-making and behaviour. *Renew. Sustain. Energy Rev.* **2015**, *41*, 1385–1394.
54. Rehdanz, K. Determinants of residential space heating expenditures in Germany. *Energy Econ.* **2007**, *29*, 167–182.
55. Nair, G.; Gustavsson, L.; Mahapatra, K. Factors influencing energy efficiency investments in existing Swedish residential buildings. *Energy Policy* **2010**, *38*, 2956–2963.
56. Poortinga, W.; Steg, L.; Vlek, C.; Wiersma, G. Household preferences for energy-saving measures: A conjoint analysis. *J. Econ. Psychol.* **2003**, *24*, 49–64.

57. Poortinga, W.; Steg, L.; Vlek, C. Values, environmental concern, and environmental behavior: A study into household energy use. *Environ. Behav.* **2004**, *36*, 70–93.
58. Sardianou, E. Estimating energy conservation patterns of Greek households. *Energy Policy* **2007**, *35*, 3778–3791.
59. Mills, B.; Schleich, J. What's driving energy efficient appliance label awareness and purchase propensity? *Energy Policy* **2010**, *38*, 814–825.
60. Mills, B.; Schleich, J. Residential energy-efficient technology adoption, energy conservation, knowledge, and attitudes: An analysis of European countries. *Energy Policy* **2012**, *49*, 616–628.
61. Wan, C.; Shen, G.Q.; Choi, S. The moderating effect of subjective norm in predicting intention to use urban green spaces: A study of Hong Kong. *Sustain. Cities Soc.* **2018**, *37*, 288–297.
62. Trotta, G. Factors affecting energy-saving behaviours and energy efficiency investments in British households. *Energy Policy* **2018**, *114*, 529–539.
63. Scheaffer, R.L.; Mendenhall, W.; Lyman Ott, R.; Kenneth, G.; Gerow, K.G. *Elementary Survey Sampling*. Cengage Learning: Boston, MA, USA, 2011.
64. Galway, L.P.; Bell, N.; Al Shatari, S.A.; Hagopian, A.; Burnham, G.; Flaxman, A.; Takaro, T.K. A two-stage cluster sampling method using gridded population data, a GIS, and Google Earth TM imagery in a population-based mortality survey in Iraq. *Int. J. Health Geogr.* **2012**, *11*, 12.
65. Xu, J.; Kang, Q.; Song, Z.; Clarke, C.P. Applications of mobile social media: WeChat among academic libraries in China. *J. Acad. Librariansh.* **2015**, *41*, 21–30.
66. Harwit, E. WeChat: Social and political development of China's dominant messaging app. *Chin. J. Commun.* **2017**, *10*, 312–327.
67. Sun, Z.J.; Zhu, L.; Liang, M.; Xu, T.; Lang, J.H. The usability of a WeChat-based electronic questionnaire for collecting participant-reported data in female pelvic floor disorders: A comparison with the traditional paper-administered format. *Menopause* **2016**, *23*, 856–862.
68. Lu, Y.; Kua, H.W.; Yu, M.; Ruan, T. Paper or screen? Examining the effectiveness of messaging delivery means in promoting household energy conservation in China. *Resour. Conserv. Recycl.* **2018**, *139*, 27–39.
69. Sarstedt, M.; Ringle, C.M.; Hair, J.F. Partial least squares structural equation modeling. In Handbook of Market Research; Homburg, C., Klarmann, M., Vomberg, A., Eds.; Springer: Cham, Switzerland, 2017; pp. 1–40.
70. Kline, R.B. *Principles and Practice of Structural Equation Modeling*; Guilford Publications: New York, NY, USA, 2015.
71. Jacobucci, R.; Grimm, K.J.; McArdle, J.J. Regularized structural equation modeling. *Struct. Equ. Model. Multidiscip. J.* **2016**, *23*, 555–566.
72. Wang, S.; Fan, J.; Zhao, D.; Yang, S.; Fu, Y. Predicting consumers' intention to adopt hybrid electric vehicles: Using an extended version of the theory of planned behavior model. *Transportation* **2016**, *43*, 123–143.
73. Wong, K.K.K. Mediation analysis, categorical moderation analysis, and higher order constructs modeling in Partial Least Squares Structural Equation Modeling (PLSSEM): A B2B Example using SmartPLS. *Mark. Bull.* **2016**, *26*, 1–22.
74. Hair, J.F.; Hult, G.T.M.; Ringle, C.M.; Sarstedt, M.; Thiele, K.O. Mirror, mirror on the wall: A comparative evaluation of composite-based structural equation modeling methods. *J. Acad. Mark. Sci.* **2017**, *45*, 616–632.
75. Alarcón, D.; Sánchez, J.A.; De Olavide, U. Assessing convergent and discriminant validity in the ADHD-R IV rating scale: User-written commands for Average Variance Extracted (AVE), Composite Reliability (CR), and Heterotrait-Monotrait ratio of correlations (HTMT). In Composite Reliability (CR), and Heterotrait-Monotrait Ratio of Correlations (HTMT), Proceedings of the Spanish Stata Meeting, Madrid, Spain, 22 October 2015; Pablo de Olavide University: Sevilla, Spain, 2015; pp. 1–39.
76. Ajzen, I. The theory of planned behaviour: Reactions and reflections. *Psychol. Health* **2011**, *26*, 1113–1127.
77. Henseler, J.; Ringle, C.M.; Sarstedt, M. A new criterion for assessing discriminant validity in variance-based structural equation modeling. *J. Acad. Mark. Sci.* **2015**, *43*, 115–135.
78. Bergquist, M.; Nilsson, A.; Schultz, W.P. A meta-analysis of field-experiments using social norms to promote pro-environmental behaviors. *Glob. Environ. Chang.* **2019**, *59*, 101941.
79. De Dominicis, S.; Sokoloski, R.; Jaeger, C.M.; Schultz, P.W. Making the smart meter social promotes long-term energy conservation. *Palgrave Commun.* **2019**, *5*, 51.
80. Stoeva, K.; Alriksson, S. Influence of recycling programmes on waste separation behaviour. *Waste Manag.* **2017**, *68*, 732–741.

81. Chen, T.X.; Zhang, B.H.; Liu, J.H.; Wang, Z.X. Strategy of grading pricing model on residential power consumption. *Power Demand Side Manag*. **2005**, *7*, 11–14.
82. Zhang, X.; Shen, J.; Yang, T.; Tang, L.; Wang, L.; Liu, Y.; Xu, P. Smart meter and in-home display for energy savings in residential buildings: A pilot investigation in Shanghai, China. *Intell. Build. Int.* **2019**, *11*, 4–26.
83. Sim, J.; Cho, D. A Multiyear Study of Smart Meter Adoption: Empirical Evidence from the United Kingdom. In Proceedings of the ICIS 2017, Seoul, Korea, 10–13 December 2017.
84. Zhang, Y.; Wang, Z.; Zhou, G. Determinants of employee electricity saving: The role of social benefits, personal benefits and organizational electricity saving climate. *J. Clean. Prod.* **2014**, *66*, 280–287.
85. Gao, L.; Wang, S.; Li, J.; Li, H. Application of the extended theory of planned behavior to understand individual's energy saving behavior in workplaces. *Resour. Conserv. Recycl.* **2017**, *127*, 107–113.
86. Prud'homme, B.; Raymond, L. Sustainable development practices in the hospitality industry: An empirical study of their impact on customer satisfaction and intentions. *Int. J. Hosp. Manag.* **2013**, *34*, 116–126.
87. Ding, Z.; Wang, G.; Liu, Z.; Long, R. Research on differences in the factors influencing the energy-saving behavior of urban and rural residents in China—A case study of Jiangsu Province. *Energy Policy* **2017**, *100*, 252–259.
88. Kang, N.N.; Cho, S.H.; Kim, J.T. The energy-saving effects of apartment residents' awareness and behavior. *Energy Build.* **2012**, *46*, 112–122.